HUMAN SETTLEMENT AND ENVIRONMENTAL CHANGE AT BARBERS POINT, O'AHU

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ABSTRACT

Recent studies at Barbers Point, O'ahu, have demonstrated an unparalleled potential there for coordinated research on human settlement and environmental change in leeward "marginal" regions of the Hawaiian Islands. The following paper presents some of the more significant results: the available data are summarized, and several interpretive models from different sources are offered.

The current level of knowledge is tantalizing to say the least. Clearly our principal limitation is one of sampling. It is expected, however, that with the definition of specific research goals this limitation can be overcome.

Preliminary environmental impact studies at Barbers Point, O'ahu, have demonstrated the unique potential there for significant contributions to the cultural and natural history of the Hawaiian Islands. Several areas of investigation are of particular interest: the survival of rare and endangered species, the extinction of endemic Hawaiian avifauna, the structure of the leeward lowland forest prior to man's arrival in the islands, and the native Hawaiian settlement of a presumed "marginal" environment. To better accomodate such diverse but parallel concerns, continuing research is coordinated in phases, beginning with intensive survey of the terrestrial biology and archaeological resources. Fieldwork for this Phase I study was completed over the past 12 months, and a detailed report is now in preparation (Davis & Griffin 1978).

The following paper summarizes the findings of the current study. Using data collected from the cultural survey, together with that recovered from excavation by the Bishop Museum (Sinoto 1976, 1978), I suggest a tentative model for interpreting the archaeological remains at Barbers Point. The model focuses on patterns of settlement and subsistence, and several alternatives are considered as testable hypotheses. This paper is of course necessarily quite preliminary. My purpose here is primarily to

open ideas for consideration and to stimulate discussion for developing and refining the direction of future research.

To begin with, the study area is located along the southwestern coast of O'ahu on a broad plain of emergent fossiliferous coral-algal reef (Fig. 1). Because the seaward portions of the region are relatively isolated from alluvial encroachment, the exposed limestone has weathered to form a shallow karst landscape. The area is characterized by numerous solution sinkholes, irregular rock masses, and poor soil development. Local climate is generally arid with intense sunshine, warm dry winds, and low annual rainfall. However, the coral plain is a major aquafer, and many of the sinkholes in the study area penetrate to the water table. Thus despite superficially arid conditions, the availability of fresh water alone is not the principal constraint on human settlement and subsistence. Indeed, as is typical of atoll environments in the tropical Pacific, the more significant factors are those resulting from the alkaline substrate and the general paucity of inorganic sediments. It is these conditions which placed particular requirements upon the adaptive strategies employed by the former inhabitants of Barbers Point.

The intensive botanical survey described and mapped the modern vegetation zones of the study area, and complementary wildlife studies defined primary habitats. The presence of a second threatened plant species, Achyranthes splendens var. rotundata Hbd., was confirmed in addition to the originally identified Euphorbia skottsbergii var. kalaeloana Sherff. The population and distribution of both species have been determined and pertinent recommendations presented (Miura & Sato 1978). An uncommon terrestrial shrimp, Halocaridina rubra, was also found in a large, flooded cave, and is briefly reported on by Miura and Sato (1978).

From this baseline study we can now begin to consider the nature of the former environment at Barbers Point. Excavations by the Bishop Museum yielded extensive remains of terrestrial mollusca and extinct avifauna as well as cultural material. In addition to known coastal, forest, and predatory species, the avian assemblage includes several new taxa, two of which are flightless forms (Sinoto 1976; Ziegler 1978). Continuing analysis of the avifauna should yield substantial information regarding the birds themselves and their habitats. The potential for paleoenvironmental reconstruction has been especially enhanced with the recovery of terrestrial mollusca. Because they are habitat specific, these snails are highly responsive to local conditions. Although sampling for land snails has been somewhat limited, the available collection indicates a varied population in which eleven species have been identified to date (Kirch 1978). Morgenstein (1978) observes that the mollusca occur in a complete and continuous biostratigraphic profile. Preliminary sediment analyses--including pollen, spores, and phytoliths--correlate with the inferred deposition of avian and molluscan remains, and attest to significant changes in the vegetation of the study area. It is suggested that an initial reduction in the resident aviary probably occurred prior to a major transition

from small-shrubbery to heavy-forest vegetation, and before human settlement of the area (Morgenstein 1978). What factors precipitated these events, however, are still uncertain. Clearly more extensive sampling will be needed before further assessments are possible.

Discussion of the archaeological remains may be initiated with three simple observations. (1) The settlement at Barbers Point was one of functionally integrated, multi-household residence groups. (2) The settlement was minimally long-term, recurrent occupation of the same habitation areas. And (3) the local subsistence pattern focused on the exploitation of marine-strand resources integrated with limited horticulture involving tree and/or root crops. Let us now consider these propositions in detail.

What is the evidence for functionally integrated, multi-household residence groups?

I have defined the archaeological evidence for such a group as the occurrence of functionally different, but contemporaneous features clustered in close spatial association. Here the assumption is that at the time of occupation, the various features of the cluster served a range of uses which, when combined, encompassed a set of activities that defined the residence group. I now suggest that the minimal group was an extended family incorporating several households similar to that outlined by Handy and Pukui (1972). The similarity is not complete, however. This is, first, because Handy and Pukui's description of the Hawaiian family is based on ethnohistoric material gathered during the 1930's in Ka'u, Hawai'i; and secondly, because many of the structural features listed for their residence group are apparently missing from the Barbers Point settlement. Specific features of this model include separated cooking and eating houses for men and women, sleeping houses, storage facilities, work areas, and a menstrual house or other place of seclusion for women (Handy & Pukui 1972: 7-11). This model clearly reflects the segregation of sexes according to the kapu system. Such proscriptions, however, may not necessarily have operated uniformally throughout the islands, among all levels of society, or during all periods of cultural development. Indeed, while Malo (1951: 118-126) describes a similar residential organization for "respectable" people, he nevertheless observes that "no accounts" often followed no such proprieties.

The habitation features recorded at Barbers Point were subjected to metric analysis using total area, interior floor area, and maximum wall width as the principal discriminating variables. Frequency distribution curves of the combined variables distinguished three classes of structures ultimately based on overall size (Fig. 2). Except for three anomolous enclosures, Class I features are C-shaped structures less than 10 m^2 in total area. Class II features include both C-shapes and walled enclosures of 17±5 m^2. And finally, Class III features are rectangular enclosures 24 m^2 or more in area.

Presence-absence trait analysis further defined these classes in functional terms. Because of their small size, shape, and virtual absence of other distinctive attributes, Class I structures are inferred to be for the storage of tools and materials, or possibly for such produce as yams and sweet potatoes. Class II features are the ordinary dwellings of individual households. Class III enclosures also appear to be ordinary dwellings. Although these enclosures are rather large when compared to other habitation features in the study area, none approach the usual size range or structural complexity to indicate more specialized features, such as men's houses.

A fourth class of habitation feature is defined from the trait analysis. These are distinguished by the presence of scattered midden and large mounds of burned coral associated with open, elevated floors. Class IV features are therefore inferred to be cooking areas using surface imu, or ovens, although oven pits may be found under the raised floors.

Extensive disturbances in the study area have left few probable clusters intact. Of the remaining examples, one cluster especially, includes seven Class I storage features, six Class II dwellings, and five Class IV cooking features in two separate areas within the cluster (Fig. 3). The habitation features are associated with structurally modified sinkholes and clearings of soil-humus deposits--both inferred to be garden areas, and with other unmodified sinkholes used as refuse dumps. The entire cluster is situated on a slight rise of limestone outcropping immediately adjacent to an area of surface drainage. Despite considerable evidence for surface runoff, the relatively minor difference in elevation does not seem sufficient to explain this location as a direct response to flooding alone. What is of interest is that shallow, but numerous pockets of silt are found in these drainages. The proximity of the habitation area to the accumulated sediments suggests that the drainages were also utilized. This may have been for additional gardening, or perhaps as a source of alluvial materials for use in mulched garden pits (sinkholes).

The one feature conspicuously missing from this cluster is the Class III enclosure. Although a Class II or several Class I features may be located nearby, the larger enclosures are in fact quite dispersed throughout the study area without any apparent pattern to their location. It is possible that these enclosures are the residences for individual households, and that the "clusters" may have functioned as communal foci for a larger settlement group. If so, then the whole nature of the residence group in terms of spatial distribution may require rethinking. Alternatively, the Class III enclosures may not be contemporaneous with the feature clusters, and their distribution may reflect changes occurring in the settlement of the area. Trait analysis suggests that Class III features are either very late prehistoric, or wholly historic phenomena. Although precontact dates of A.D. 1666±41 and 1743±41 were obtained from one such enclosure tested by the Bishop Museum (Sinoto 1976: 87), the

artifact assemblage was clearly historic. This was true also of surface remains recorded in an adjacent feature during the present study.

Whether these or other changes, and the conditions which may have induced these changes, were occurring at Barbers Point during the period of settlement are intriguing and important questions for investigation.

What is the evidence that the settlement was minimally long-term and recurrent occupation of the same habitation areas?

Adequate temporal controls have yet to be established. Nevertheless, that feature clusters initially conforming to my definition of a residence group are present in the study area indicates that the resident population must have included whole families. This would not likely have been the case if Barbers Point were merely the temporary campsite of itinerant specialists. In the one instance where a range of dates are available from a single feature (a Class II enclosure), the span of occupation is over 250 years (Sinoto 1976: 87). At least two separate events altered the nature of this site: the filling of a sinkhole adjacent to a living floor followed by the building of the present enclosure wall. Whether or not this represents continuous occupation has not been resolved. But it does suggest that use of the site may have become more formalized through time. Again, this does not seem to be consistent with short-term, or transient habitation.

It is evident that an argument can initially be made for extended, recurrent residence in the study area. The possibility of permanent habitation, however, remains an open question. Tight stratigraphic control within and temporal control between habitation features are minimally essential for resolving these and other crucial questions raised by the available data.

What is the evidence for local subsistence based on the exploitation of marine-strand resources integrated with limited horticulture?

The artifact and midden assemblage clearly shows the use of marine and strand resources. Shellfish were collected from the shoreline and the reef. Octopus was taken from the reef on hook and line using cowrie-shell lures. And in-shore fishing was done with lines using small rotating and jabbing fishhooks. Off-shore line fishing is also indicated by large, one-piece rotating fishhooks (Sinoto 1976), by fragments of large points probably for two-piece trolling lures (Lewis 1970; Sinoto 1978), and by the remains of tuna in the midden (Sinoto 1978).

Although the availability of fresh water is not considered a major obstacle to the growth of cultivated plants, the present evidence for horticulture is largely circumstantial. The numerous walled sinkholes, enclosed humus-filled depressions, and

small clearings of soil-humus deposits are inferred to be garden areas. Ethnographic correlates for the walled sinkholes are found elsewhere across the tropical Pacific. On the low coralline atolls tree and root crops are frequently grown in mulched garden pits to utilize the limited ground water, and to overcome the excessive alkalinity of the carbonate substrate (Barrau 1961). Similar strategies for conserving moisture, such as low-walled windbreaks and intensive mulching, have been documented from arid localities elsewhere in Hawai'i. Then there is the continued survival of several native economic plant species, particularly noni and ti, found thriving in the study area.

Depending upon the plants involved, gardening at Barbers Point would potentially have been a labor-intensive activity. Tree crops, for instance, probably required only occasional tending once they were well started. The persistence of noni, ti, and others in the deeper sinkholes indicates that these plants are capable of supplying sufficient natural mulch in the form of leaf litter to ensure continued growth. On the other hand, the level of mulching required to reduce excessive alkalinity and provide a suitable medium for productive growth of root crops would have been a demanding activity. If indeed root crops were grown in the study area, then this point can be taken further to suggest that at least a part of the population at Barbers Point was permanently resident there.

To obtain direct evidence for cultivation, or indirect evidence of the potential for cultivation, will require largely a comparative approach. Both the inferred horticultural features and the "natural," or unmodified, features must be sampled to meet two criteria. It must be demonstrated (1) that the deposits in the culturally modified features are consistently similar from one feature to the next, and (2) that the deposits in the modified features are significantly different from those in the unmodified features. Once these conditions are fulfilled, it must be further established that plant cultivation is the most reasonable explanation accounting for the differences between the two sample groups. Direct evidence may include macrofossils like yam or sweet potato tubers, or more likely, microfossils such as the pollen, spores, or phytoliths from the cultivated plants. Although less satisfying, indirect evidence would largely be based on first determining the proper growth medium required by the presumed cultivated plants. Secondly, it must be shown that the proper conditions are, or were present in the modified features, and not in the unmodified features.

The most intriguing question, and the one for which the least empirical data is currently available, is the relationship between the remains of the extinct avifauna and that of the human settlement. It has already been suggested that the major reduction in the Barbers Point aviary apparently occurred prior to human settlement. However, this is a very preliminary assessment requiring further confirmation. Direct affects of human predation, or significant disruption of habitat resulting from other unassociated events, cannot yet be discounted as possible contributive factors in the extinction of selected bird species.

SUMMARY

Barbers Point is a geologically unique area for the high volcanic islands of Hawai'i. Located on the coast of an extensive raised coral-reef plain and isolated from alluvial encroachment, the exposed limestone has weathered to form a shallow karst landscape. Karst environments are alkaline, ideal for the preservation of bone and vegetal debris. Yet the area had received little serious attention and was generally viewed as too marginal to have supported a significant precontact population. Routine environmental impact studies in conjunction with a proposed harbor development have since reversed this opinion.

Intensive cultural surveys indicate that Barbers Point was more extensively settled than had previously been considered. Pending detailed excavations, the initial data suggest a settlement of multi-household residence groups over a time span of c. A.D. 1600 to 1870. Local subsistence was based in part on marine-strand resources, and apparently integrated with limited cultivation adapted to make use of the many sinkholes that characterize the area. Other relationships have yet to be determined.

For the natural sciences, biological surveys have identified an uncommon endemic terrestrial shrimp and rare and endangered plant species. Of greater significance is the potential for paleontological and paleoenvironmental studies, particularly regarding the bird life and forest structure of the leeward lowlands prior to man's arrival in the islands. Limited test excavations have recovered the remains of several new taxa of extinct birds, including flightless forms. Varieties of land snails have also been identified from the excavations. Highly responsive to local conditions, these snails attest to significant changes in the vegetation at Barbers Point.

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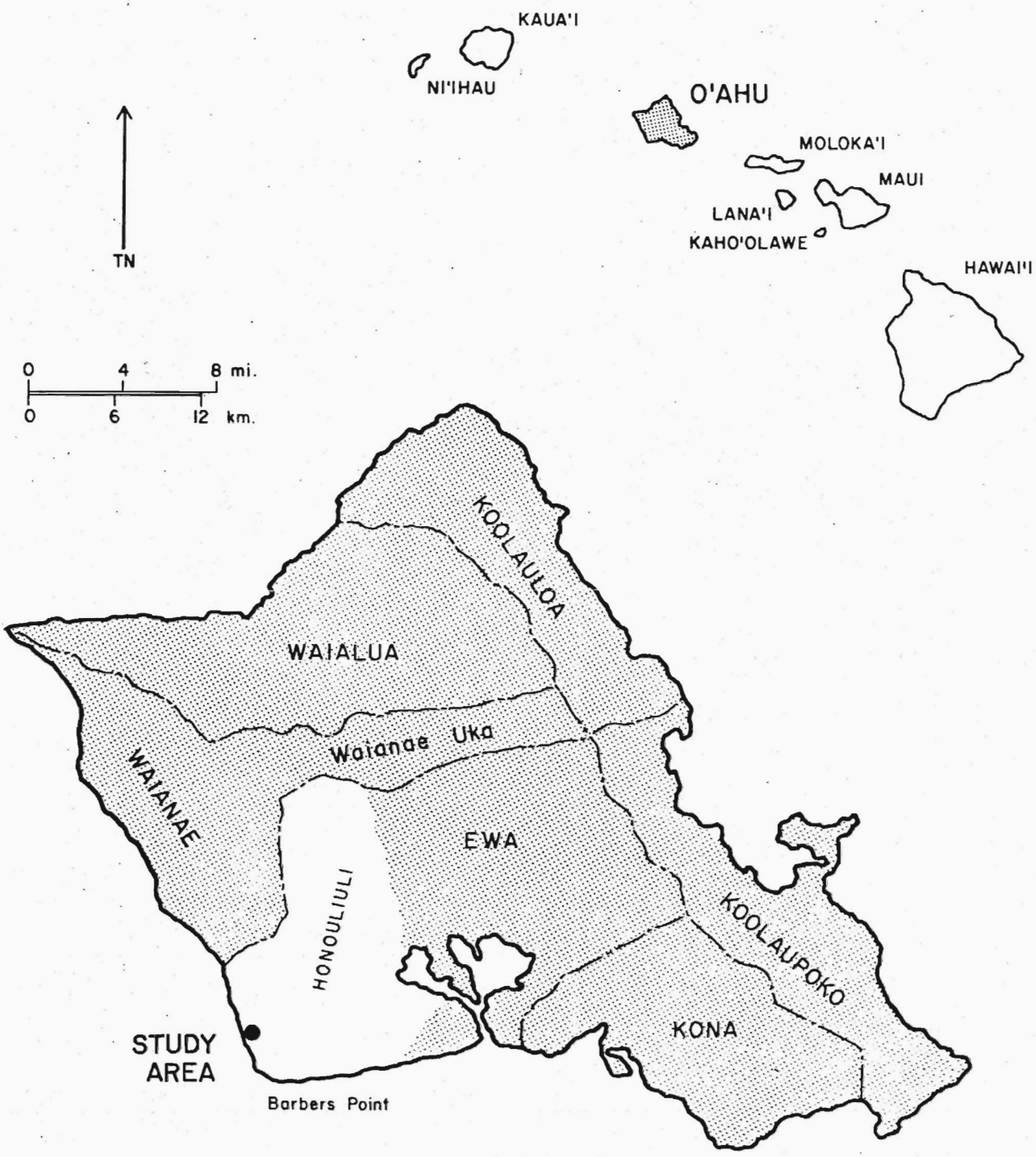

FIGURE 1. Map of O'ahu and the Hawaiian Islands showing the location of the Barbers Point Study Area.

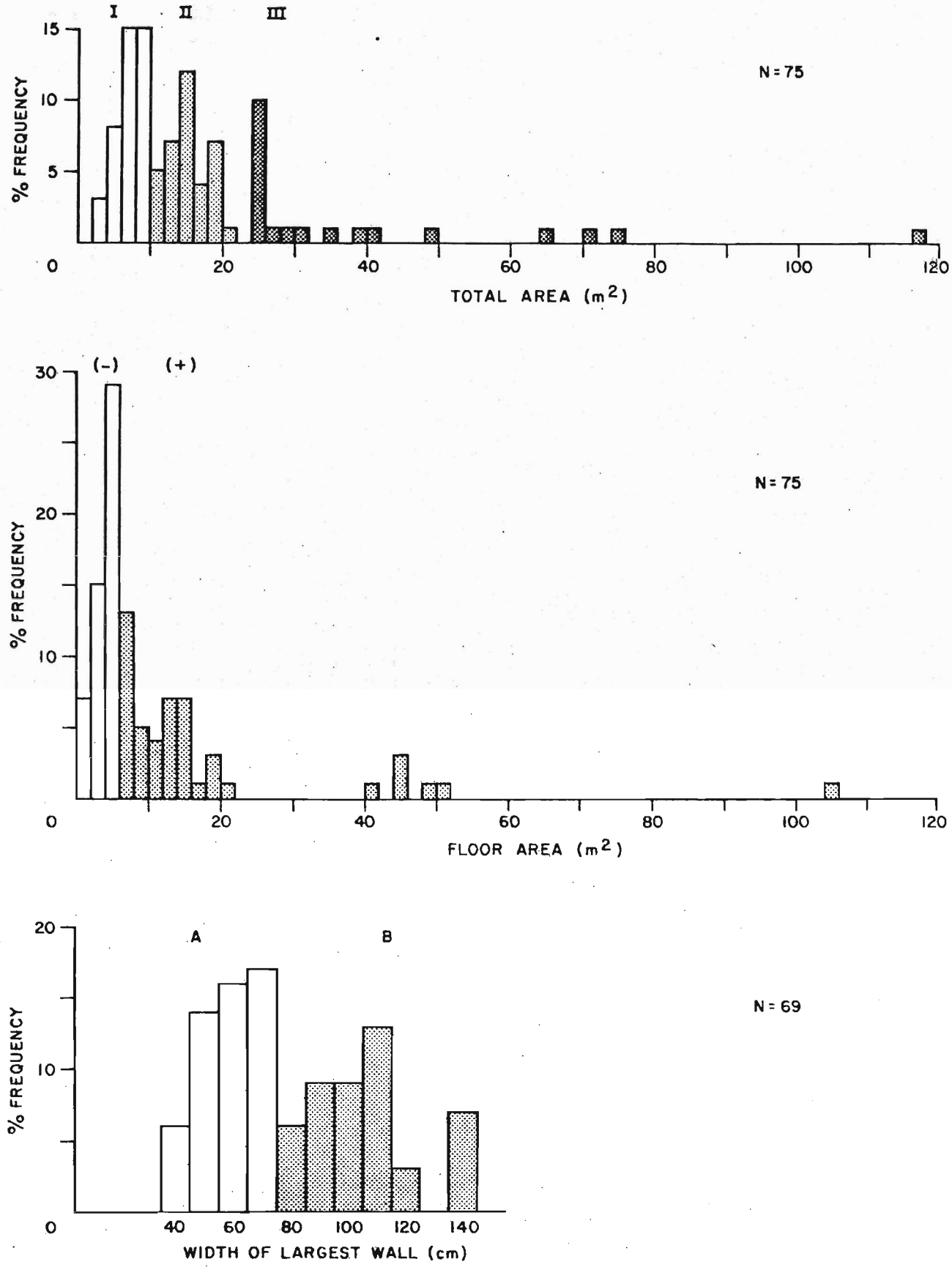

FIGURE 2. Frequency distribution graphs for total area, interior floor area, and width of largest wall for habitation features from the Barbers Point Study Area.

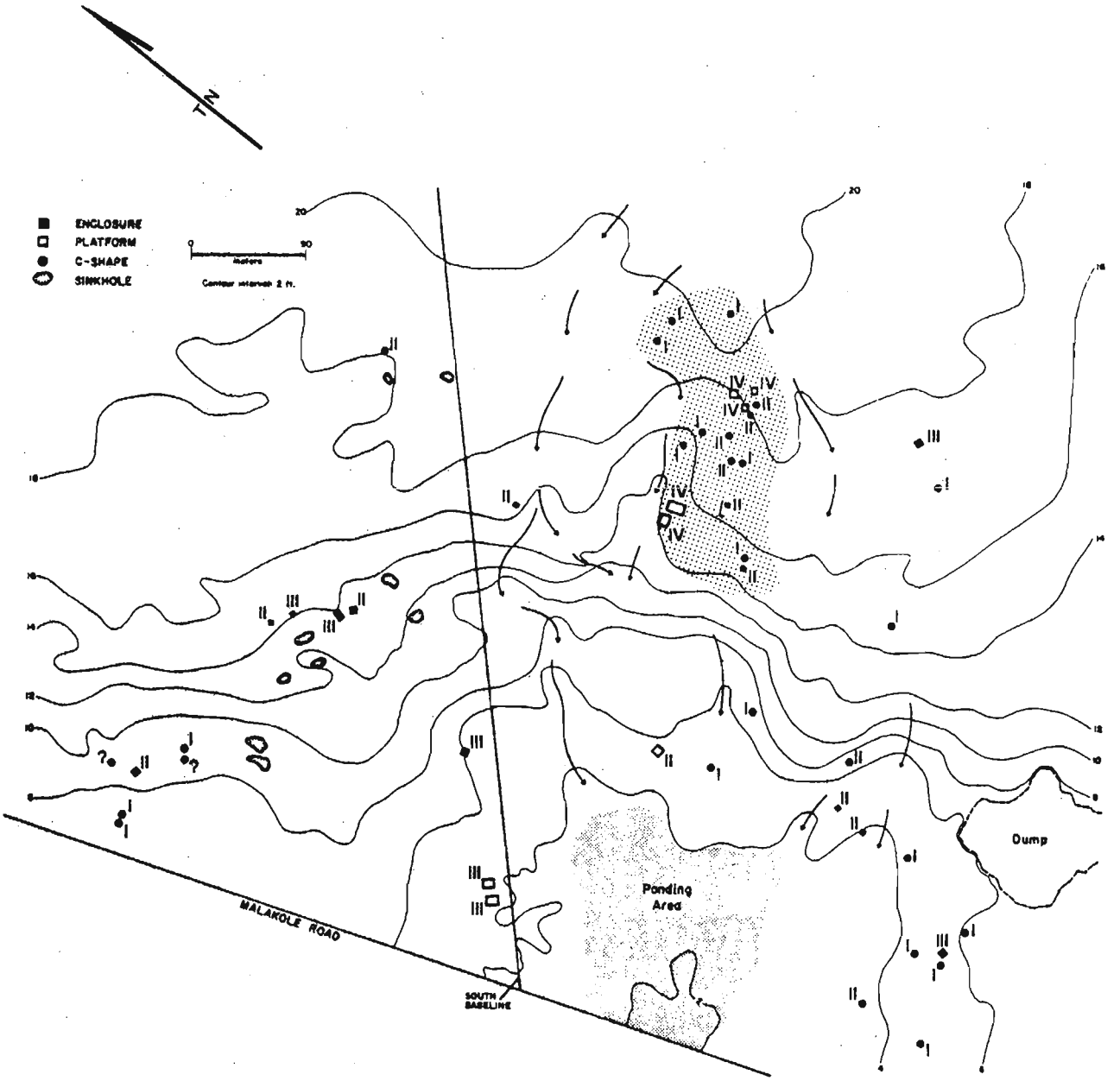

FIGURE 3. Topographic map of a portion of the Barbers Point Study Area showing the distribution of habitation features and the location of surface drainages. Stippled area indicates feature cluster discussed in text.